

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Title of the Invention

Multifunctional Charger System and Method

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Multifunctional Charger System and MethodCROSS-REFERENCE TO RELATED APPLICATIONS

5 This application claims priority from and is related to United States Provisional Application No. 60/273021, entitled "System and Method for Adapting a USB to Provide Power for Charging a Mobile Device," which was filed on March 1, 2001. United States Provisional Application No. 60/273021 is hereby incorporated into the present application by reference.

10 This application also claims priority from and is related to United States Provisional Application No. 60/330486, entitled "Multifunctional Charger System and Method", which was filed on October 23, 2001. United States Provisional Application No. 60/330486 is hereby incorporated into the present application by reference.

BACKGROUND

1. Field of the Invention

15 This invention relates generally to power adapters. More particularly, the invention relates to power adapters for use with mobile devices.

2. Description of the Related Art

20 Providing an external source of power to a mobile device, such as a personal digital assistants ("PDA"), mobile communication device, cellular phone, wireless two-way e-mail communication device, and others, requires design considerations with respect to both the mobile device and the power source. With regard to the mobile device, most mobile devices provide a distinct power interface for receiving power from a power source, for instance to recharge a battery, and a separate data interface for communicating. For example, many mobile devices

presently use USB (Universal Serial Bus) interfaces for communicating and use a separate power interface, such as a barrel connector, for receiving power.

It is desirable, however, to have a combined power and data interface. The mobile devices that do have combined power and data interfaces typically use non-standard and sometimes proprietary interfaces. Consequently, combined interfaces for a particular manufacturer's mobile device may not be compatible with combined interfaces for mobile devices provided by other manufacturers.

Although the USB interface can be used as a power interface, the USB is typically not used for that purpose by mobile devices. In accordance with the USB specification, typical USB power source devices, such as hubs and hosts, require that a USB device participate in a host-initiated process called enumeration in order to be compliant with the current USB specification in drawing power from the USB interface. Although a mobile device could be adapted to participate in enumeration when drawing power over the USB interface, it would be preferable in many situations, such as when a host would not be available, as often happens during normal use of a mobile device, to be able to utilize alternate power sources such as conventional AC outlets and DC car sockets that are not capable of participating in enumeration to supply power to the mobile device via a USB interface.

SUMMARY

An adapter for providing a source of power to a mobile device through an industry standard port is provided. In accordance with one aspect of the invention, the adapter comprises a plug unit, a power converter, a primary connector, and an identification subsystem. The plug unit is operative to couple the adapter to a power socket and operative to receive energy from the

power socket. The power converter is electrically coupled to the plug unit and is operable to regulate the received energy from the power socket and to output a power requirement to the mobile device. The primary connector is electrically coupled to the power converter and is operative to couple to the mobile device and to deliver the outputted power requirement to the mobile device. The identification subsystem is electrically coupled to the primary connector and is operative to provide an identification signal.

In accordance with another aspect, a USB adapter for providing a source of power to a mobile device through a USB port is provided. The USB adapter comprises a plug unit, a power converter, a primary USB connector, and an identification subsystem. The plug unit is operative to couple the USB adapter to a power socket and operative to receive energy from the power socket. The power converter is electrically coupled to the plug unit and is operable to regulate the received energy from the power socket and to output a power requirement to the mobile device. The primary USB connector is electrically coupled to the power converter and is operative to couple to the mobile device and to deliver the outputted power requirement to the mobile device. The identification subsystem is electrically coupled to the primary connector and is operative to provide an identification signal.

Another aspect provides a USB adapter for providing a source of power to a mobile device through a USB port. The USB adapter comprises a plug unit, a power converter, a primary USB connector, and an auxiliary USB adapter. The plug unit is operative to couple the USB adapter to a power socket and operative to receive energy from the power socket. The power converter is electrically coupled to the plug unit and is operable to regulate the received energy from the power socket and to output a power requirement to the mobile device. The primary USB connector is electrically coupled to the power converter and is operative to couple

to the mobile device and to deliver the outputted power requirement to the mobile device. The auxiliary USB connector has data lines that are electrically coupled to the data lines of the primary USB connector.

Yet another aspect provides a method for providing energy to a mobile device using a USB adapter that comprises a plug unit, a primary USB connector, a power converter electrically coupled between the plug unit and the primary USB connector, and an identification subsystem electrically coupled to the primary USB connector. The method comprising the steps of coupling the USB connector to the mobile device, coupling the plug unit to a power socket, outputting a power requirement to the mobile device via the power converter and the USB connector, and providing an identification signal to the mobile device, via the identification subsystem and the USB connector, that is operative to inform the mobile device that the USB adapter is not limited by the power limits imposed by the USB specification.

In accordance with another aspect, a powering system for a mobile device having a USB connector is provided. The powering system comprises a power distribution subsystem in the mobile device that is operable to receive energy through the USB connector and to distribute the energy to at least one component in the mobile device and a USB adapter that is operative to couple to the USB connector.. The USB adapter comprises a plug unit for coupling to a power socket and that is operable to receive energy from the power socket, a power converter electrically coupled to the plug unit for regulating the received energy and for providing a power requirement to the power distribution subsystem, and an identification subsystem that is operable to transmit an identification signal that is operative to identify the USB adapter as not being limited by the power limits imposed by the USB specification.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention identified in the claims may be more clearly understood, preferred embodiments thereof will be described in detail by way of example, with reference to the accompanying drawings, in which:

5 Fig. 1 is a schematic diagram of an exemplary mobile device which has an industry standard interface;

Fig. 2 is a schematic diagram of a first embodiment of a USB adapter that is coupled to an exemplary mobile device;

Fig. 3 is a flow chart illustrating an exemplary use of a USB adapter with a mobile device; and

Fig. 4 is a schematic diagram of an additional exemplary embodiment of a USB adapter that is coupled to both an exemplary mobile device and an external battery.

DETAILED DESCRIPTION

15 **Exemplary Mobile Device**

Turning now to the drawing figures, shown in Fig. 1 is a schematic diagram of an exemplary mobile communication device **10** which has an industry standard interface. The mobile communication device **10** is preferably a two-way communication device having at least voice or data communication capabilities. Preferably, the mobile device **10** is also capable of communicating over the Internet, for example, via a radio frequency ("RF") link. Examples of types of devices that could be classified as a mobile device **10** include a data messaging device, a two-way pager, a cellular telephone with data messaging capabilities, a wireless Internet appliance, a data communication device (with or without telephony capabilities), a personal digital assistants ("PDA"), a wireless two-way e-mail communication device, and others.

The exemplary mobile device **10** comprises a microprocessor **12**, a communication subsystem **14**, input/output (“I/O”) devices **16**, an industry standard interface **18** which in this example is a USB port, and a power subsystem **20**. The microprocessor **12** controls the overall operation of the mobile device **10**. The communication subsystem **14** provides the mobile device **10** with the ability to communicate wirelessly with external devices such as other mobile devices and other computers. The I/O devices **16** provide the mobile device **10** with input/output capabilities for use with a device user. The USB port **18** provides the mobile device **10** with a serial port for linking directly with other computers and/or a means for receiving power from an external power source. The power subsystem **20** provides the mobile device **10** with a local power source.

The exemplary communication subsystem **14** comprises components such as a receiver **22**, a transmitter **24**, antenna elements **26** and **28**, local oscillators (LOs) **30**, and a processing module such as a digital signal processor (DSP) **32**. The particular design of the communication subsystem **14** and the components used therein can vary. It would be apparent to one of ordinary skill in the art to design an appropriate communication subsystem using conventional methods and components to operate over a communication network **34** based on the parameters necessary to operate over that communication network. For example, a mobile device **10** geographically located in North America may include a communication subsystem **14** designed to operate within the Mobitex™ mobile communication system or DataTAC™ mobile communication system, whereas a mobile device **10** intended for use in Europe may incorporate a General Packet Radio Service (GPRS) communication subsystem **14**.

Network access requirements will also vary depending upon the type of network **34**. For example, in the Mobitex and DataTAC networks, mobile devices **10** are registered on the

network using a unique personal identification number or PIN associated with each device. In GPRS networks however, network access is associated with a subscriber or user of a mobile device **10**. A GPRS device therefore requires a subscriber identity module (not shown), commonly referred to as a SIM card, in order to operate on a GPRS network. Without a SIM card, a GPRS device will not be fully functional. Local or non-network communication functions (if any) may be operable, but the mobile device **10** will be unable to carry out any functions involving communications over the network **34**.

When required, after the network registration or activation procedures have been completed, a mobile device **10** may send and receive communication signals over the network **34**. Signals received by the receiver antenna **26** through a communication network **34** are input to the receiver **22**, which may perform such common receiver functions as signal amplification, frequency down conversion, filtering, channel selection and the like, and in the exemplary system shown in Fig. 1, analog to digital conversion. Analog to digital conversion of a received signal allows more complex communication functions such as demodulation and decoding to be performed in a DSP **32**. Similarly, signals to be transmitted are processed, including modulation and encoding for example, by the DSP **32** and input to the transmitter **24** for digital to analog conversion, frequency up conversion, filtering, amplification and transmission over the communication network **34** via the transmitter antenna **28**.

Also, in the exemplary communication subsystem **14**, the DSP **32** processes communication signals and also provides for receiver and transmitter control. For example, the gains applied to communication signals in the receiver **22** and transmitter **24** may be adaptively controlled through automatic gain control algorithms implemented in the DSP **32**.

In implementing its control function, the microprocessor **12** in the exemplary mobile device **10** executes an operating system. The operating system software used by the microprocessor **12** is preferably stored in a persistent store such as flash memory **36**, or alternatively read only memory (ROM) or similar storage element. The microprocessor **12** may also enable the execution of specific device applications, which preferably are also stored in a persistent store. The operating system, specific device applications, or parts thereof, may also be temporarily loaded into a volatile store such as in RAM **38**.

A predetermined set of applications which control basic device operations, including at least data and voice communication applications for example, will normally be installed on the mobile device **10** during manufacture. One such application loaded on the mobile device **10** could be a personal information manager (PIM) application. The PIM application preferably is an application for organizing and managing user inputted data items such as e-mail, calendar events, voice mails, appointments, and task items. The PIM data items may be stored in the RAM **38** and/or the flash memory **36**.

The PIM application preferably has the ability to send and receive data items, via the wireless network **34**. The PIM data items are preferably seamlessly integrated, synchronized and updated, via the wireless network **34**, with corresponding data items stored or associated with a host computer system (not shown) used by the device user. The synchronization of PIM data items is a process by which the PIM data items on the mobile device **10** and the PIM data items on the host computer system can be made to mirror each other.

There are several possible mechanisms for loading applications onto the mobile device **10**. For example, applications may be loaded onto the mobile device **10** through the wireless network **34**, an auxiliary I/O subsystem **40**, the serial port **18**, a short-range communications

subsystem **42**, such as an infrared (“IR”) communication system, or any other suitable subsystem **44**. When loading the applications onto the mobile device **10**, the device user may install the applications in the RAM **38**, the flash memory **36**, or preferably a non-volatile store (not shown) such as ROM for execution by the microprocessor **12**. The available application installation mechanisms can increase the utility of the mobile device **10** by providing the device user with a way of upgrading the mobile device **10** with additional and/or enhanced on-device functions, communication-related functions, or both. For example, a secure communication application may be loaded onto the mobile device **10** that allows for electronic commerce functions or other financial transactions to be performed using the mobile device **10**.

The I/O devices **16** may be used to display and/or compose data communication messages. In one mode of operation, a signal received by the mobile device **10**, such as a text message or web page download, will be received and processed by the communication subsystem **14**, forwarded to the microprocessor **12**, which will preferably further process the received signal, and provide the processed signal to one or more of the I/O devices **16** such as a display **46**. Alternatively, a received signal such as a voice signal can be provided to a speaker **48**, or alternatively to an auxiliary I/O device **40**. In another mode of operation a device user may compose a data item such as an e-mail message using a keyboard **50** in cooperation with the display **46** and possibly an auxiliary I/O device **40**. Alternatively, a device user may compose a voice message via a microphone **52**. The composed data item may then be transmitted over a communication network **34** using the communication subsystem **14**.

A short-range communications subsystem **42** may be provided in the mobile device **10** to allow the mobile device **10** to communicate with other systems or devices, which need not necessarily be similar to device **10**. For example, the short-range communications subsystem **42**

may include an infrared device and associated circuitry and components or a Bluetooth™ communication module to allow the device 10 to communicate with similarly-enabled systems and devices.

5 The USB port 18 provides the mobile device 10 with a serial port for linking directly with other computers to exchange data and/or to receive power. The USB port 18 also provides the mobile device 10 with a means for receiving power from an external power source. For example, in a personal digital assistant (PDA)-type communication device, the USB port 18 could be used to allow the mobile device 10 to synchronize data with a user's desktop computer (not shown). The USB port 18 could also enable a user to set parameters in the mobile device 10 such as preferences through the use of an external device or software application. In addition the USB port 18 may also be used to provide a means for downloading information or software to the mobile device 10 without using the wireless communication network 34. The USB port 18 can provide a direct and thus reliable and trusted connection that may for example be used to load an encryption key onto the mobile device 10 thereby enabling secure device
15 communication.

Coupled to the USB port 18 is a USB connector 54. The USB connector 54 is the physical component that couples the USB port to the outside world. In the exemplary mobile device 10, the USB connector 54 is used to transmit and receive data from an external data/power source 56, receive power from the external data/power source 56, direct the
20 transmitted/received data from/to the USB port 18, and direct the received power to the power subsystem 20.

The exemplary power subsystem 20 comprises a charging and power distribution subsystem 58 and a battery 60. The charging and power distribution subsystem 58 performs

many functions. It may be used to transfer energy to the battery 60 from the external data/power source 56 to charge the battery 60 and also to distribute power to the many power requiring components within the mobile device 10. The charging subsystem 58 may be capable of determining the presence of a battery 60 and/or a power circuit coupled to the mobile device 10, such as an AC adapter, USB connection, or car adapter, which alternatively can act as power sources 56 to provide power for the mobile device 10 and to charge the battery 60. Additionally, the charging subsystem 58 may have the ability to determine if a power source 56 is coupled to the mobile device 10 and, in the absence of such a coupling, cause the mobile device 10 to be powered by the battery 60.

The power distributed by the charging and power distribution subsystem 58 may be derived from energy stored in the battery 60 and/or energy received from the external data/power source 56. When the battery 60 is depleted, the charging and power distribution subsystem 58 transfers energy from the power source 56 to recharge the battery 60. Optionally, the charging and power distribution subsystem 58 may also transfer energy from the power source 56 to other components in the mobile device 10 to power the mobile device 10 when the battery 60 has been depleted and is recharging. When the data/power source 56 is not connected to the mobile device 10, power for the device 10 is derived from the battery 60.

Exemplary USB Adapter

Fig. 2 is a schematic diagram of a first embodiment of an adapter 100 that can be used to couple the mobile device 10 of fig. 1 to the data/power source 56 of fig. 1. In this example the adapter 100 is a USB adapter 100 that comprises a primary USB connector 102, a power converter 104, a plug unit 106, and an identification subsystem 108. The power converter is a known element in the art and typically includes at least one of the following components: switching converter, transformer, DC source, voltage regulator, linear regulator and rectifier. In

the embodiment shown in fig. 2, the USB adapter **100** is shown coupling a mobile device **10** to one of one or more types of power sockets **110N**, **110D**, **110B**, and **100**. Also shown in fig. 2 is an optional auxiliary USB connector **112** that can be used to couple the mobile device **10** to a data source (not shown) such as a personal computer.

5 In the embodiment shown in fig. 2, the primary USB connector **102** is configured to mate with the USB connector **54** of the mobile device **10**. The USB adapter **100** is operable to provide power to the mobile device **10** through the Vbus and Gnd power pins in the USB connectors **54** and **102**. The USB adapter **100** also optionally provides a communication path for data across the D+ and D- data pins in the USB connectors **54** and **102**.

10 The plug unit **106** is preferably a conventional plug unit that can be used to couple with a conventional power socket to receive power therefrom. For example, the plug unit **106** can be a two prong or three prong plug of the type used in North America that can couple to a North American AC power socket **110N** that provides 115 VAC. In the embodiment shown in figure 2, the plug unit **106** can accept one or more types of plug adapters **114N**, **114B**, **114D**, and **114** that are configured to couple to the plug unit **106** and are further configured to directly mate with one or more types of power sockets **110N**, **110D**, **110B**, and **100**. The plug unit **106** can be configured to receive energy from a power socket **110N**, **110D**, **110B**, or **100**, either directly or through the use of a plug adapter, and is operative to transfer the received energy to the power converter **104**.

20 The power converter **104** is operative to receive energy from a power socket **110N**, **110D**, **110B**, or **100** and to convert that received energy to a form that can be used by the mobile device **10**. For example, the power converter **104** can be of conventional construction such as a switching power converter that converts 115 VAC to 5 VDC. Also, the power converter **104**

could comprise a D.C. regulator circuit that converts a D.C. input to a D.C. output. The power converter **104** could also be adapted to accept a wide range of input energy levels and frequencies. Alternatively, the power converter **104** could be adapted to accept a limited range of input energy levels and frequencies, wherein the plug adapters are operable to convert the possible input energy levels and frequencies to a range that the power converter can accommodate. The power converter **104** provides its energy output to the mobile device **10** via the Vbus and Gnd pins of the primary USB connector **102**.

Through the use of a variety of different types of plug adapters, the USB adapter **100** can be adapted to receive energy from various types of power sockets **110N**, **110D**, **110B**, or **100**. For example, using the appropriate plug adapter **114**, **114B**, **114D**, and **114N**, the USB adapter **100** can receive energy from a power socket such as an 115 VAC North American power socket **110N**, or a 12 VDC automobile power socket, or an air power socket, or others.

For example, in North America, a type “N” power socket is commonly available. The plug adapter **114N** can be releasably attached to the plug unit **106** thereby allowing any North American power socket **114N** to be used as a power source. When traveling to a locale which does not have the North American power socket **114N**, an alternate plug adapter such as adapters **114**, **114B**, or **114D** may be selected by the user, according to the power socket **110D**, **110B**, or **100** available at the locale. The plug adapter **114**, **114B**, or **114D** may then be releasably attached to plug unit **106** in place of the plug adapter **114N**, thereby allowing the USB power adapter **100** to connect to a local power supply via the local power socket . Various other plug adapters are envisioned that can be configured to operate with alternate power sources such as for instance car sockets.

The power distribution and charging subsystem **58** of the mobile device **10** can selectively use the power provided on the Vbus and Gnd lines of the USB connector **54** to provide power to the mobile device **10**, charge the battery **60**, or both. A more detailed discussion of how the charging function of mobile device **10** can be implemented is described in
5 United States Provisional Application No. 60/273021 filed on March 1st, 2001 and entitled “System and Method for Adapting a USB to Provide Power for Charging a Mobile Device” which has been incorporated herein by reference.

Typically when a mobile device **10** receives power over the USB from a USB host, it is required to draw power in accordance with the USB specification. The USB specification specifies a process for transferring energy across the USB called enumeration and limits the electrical current that can flow across the USB.

The USB adapter **100** contributes to a system wherein a device **10** that follows the USB specification when coupled to a typical USB host via its USB port can be informed that the USB adapter **100** has been coupled to the device **10** and that the device **10** can now draw power
15 without regard to the USB specification and the USB specification imposed limits.

The identification subsystem **108** provides an identification signal to the mobile device **10** that the power source is not a USB limited source. The identification signal could be the communication of a single voltage on one or more of the USB data lines, different voltages on the two data lines, a series of pulses or voltage level changes, or other types of electrical signals.
20 The identification subsystem **108** that generates the identification signal could have multiple types of configurations. In one embodiment, the identification subsystem **108** comprises a hard-wired connection of a single voltage level to both data lines. In another embodiment, the identification subsystem **108** comprises a USB controller that is operable to communicate an

identification signal to the mobile device. Additional embodiments are contemplated. The identification subsystem **108** may optionally be configured to have the capability of electrically connecting or disconnecting the power output from the power converter **104** from the USB connector **102** and/or to connect or disconnect any data inputs from the USB adapter **100** to the USB connector **102**.

In addition to providing power to the mobile device **10** over the primary USB connector **102**, the USB adapter **100** may optionally be equipped with an auxiliary USB connector **112** that allows the USB adapter **100** to create a communication path between the mobile device **10** and some other device capable of communicating over the USB such as a personal computer, another mobile device or some other type of device.

The USB adapter **100** preferably provides a communication path between the D+ and D- pins of the Primary USB connector **102** and the D+ and D- pins of the auxiliary USB connector **112**. In the embodiment shown, the communication path also traverses the identification subsystem **108**. Alternatively, the communication path could bypass the identification subsystem **108**. The USB adapter **100** can thus act as a pass through device for communication between a USB hub or host and a mobile device **10**.

Optionally, the USB adapter **100** could also transfer energy from the power converter **104** to the auxiliary USB connector **112** thereby providing a device coupled to the auxiliary USB connector **112** with power. In this arrangement, the identification subsystem **108** could also provide an identification signal to the device coupled to the auxiliary USB connector **112** to inform that device that the power source is not a USB limited source.

Exemplary Illustration Of The Use of A USB Adapter With A Mobile Device

When a USB adapter **100** is connected to a mobile device **10**, the identification subsystem **108** of the USB adapter **100** preferably provides an identification signal to the mobile

device **10** to notify the mobile device **10** that the device **10** is connected to a power source that is not subject to the power limits imposed by the USB specification. Preferably, the mobile device **10** is programmed to recognize the identification signal and therefore recognizes that an identification signal has been transmitted by the USB adapter **100**. After recognizing a valid identification signal, the mobile device **10**, draws power through the USB adapter **100** without waiting for enumeration or charge negotiation.

The detection of the identification signal may be accomplished using a variety of methods. For example, the microprocessor **12** may detect the identification signal by detecting the presence of an abnormal data line condition at the USB port **18**. The detection may also be accomplished through the use of other device subsystems **44** in the mobile device **10**. The preferred identification signal results from the application of voltage signals greater than 2 volts to both the D+ and D- lines in the USB connector. The preferred method of identification is described below in greater detail with reference to Fig. 3.

At step **210**, the mobile device **10** detects the presence of a voltage on the Vbus line of the USB connector **54** via the USB port **18**. At step **220**, the mobile device checks the state of the D+ and D- lines of the USB connector. In the example shown in the drawings, the D+ and D- lines are compared to a 2V reference. Also, in this example, the identification subsystem **108** of the USB adapter **100** may have applied a logic high signal, such as +5V reference, to both the D+ and D- lines to identify the attached device as a USB adapter **100**. If the voltages on both the D+ and D- lines of the USB connector are greater than 2 Volts (step **220**), then the mobile device **10** determines that the device connected to the USB connector **54** is not a typical USB host or hub and that a USB adapter **100** has been detected (step **230**). The mobile device **10** can then

charge the battery or otherwise use power provided via the Vbus and Gnd lines in the USB connector **54** (step **260**) without waiting for enumeration.

If, however, after the mobile device **10** detects the presence of a voltage on the Vbus line of the USB connector **54** and determines that the voltages on both the D+ and D- lines of the USB connector are not greater than 2 Volts (step **220**), then the mobile device **10** determines that a USB host or hub has been detected (step **240**). A typical USB host or hub weakly holds its D+ and D- lines at zero volts when it is not connected to another device. The mobile device **10** can then signal the USB host or hub to initiate the enumeration process (step **250**) and can charge the battery or otherwise use power provided via the Vbus and Gnd lines in the USB connector (step **260**) in accordance with the power limits imposed by the USB specification. The enumeration process is typically initiated after the mobile device **10** applies approximately zero volts to the D- line and approximately 5 volts to the D+ line to inform the host of the mobile device's **10** presence and communication speed.

Therefore, when a USB adapter **100** is coupled to the mobile device **10** and has been identified as a USB adapter **100**, the mobile device **10** can forego the enumeration process and charge negotiation process and immediately draw energy from the USB power adapter **100** at a desired rate, for instance at 5 unit loads, i.e. 500mA. While the mobile device **10** charges its battery using the USB adapter **100**, the mobile device **10** can disable its typical USB functions. If, however, the mobile device **10** detects that a USB host or hub is coupled to the mobile device **10**, the mobile device **10** can apply a voltage to the D+ line to indicate to the USB host or hub that the mobile device **10** is coupled thereto and await enumeration and USB charge negotiation.

If the USB adapter **100**, is coupled to the mobile device **10**, and the mobile device **10** does not identify the USB adapter **100** through communications with the identification module

108, the mobile device 10 may stop drawing energy from the Vbus and Gnd lines of the USB connector 54. This may occur, for example, if the mobile device 10 is not programmed to identify the USB adapter 100. The mobile device 10 may mistakenly identify the USB adapter 100 as a typical USB host or hub and await enumeration before drawing substantial energy. To guard against this, the USB adapter 100 can optionally be adapted to function with mobile devices that are not programmed to recognize the USB adapter 100.

In that scenario, the USB adapter 100 can be adapted to provide energy to a mobile device by using the knowledge that the mobile device will draw energy from a connected device for a period of time before it stops drawing energy due to lack of enumeration. The USB adapter 100 can optionally provide power for charging a battery 60 in a mobile device by periodically switching the voltages on the Vbus and Gnd lines between on and off states. When the USB adapter 100 is coupled to the mobile device, the identification subsystem 108 can apply an on-voltage (5 V for example) between the Vbus and Gnd lines. The mobile device will draw energy while awaiting enumeration. After a period of time, the identification subsystem 108 can apply an off-voltage (0 volts) between the Vbus and Gnd lines thereby fooling the mobile device into determining that the unidentified USB device has been disconnected from the mobile device. The identification subsystem 108 can then reapply an on-voltage between the Vbus and Gnd lines. The mobile device will draw energy again while awaiting enumeration. This cycle can be repeated to periodically apply energy to the mobile device, for example, to recharge the battery 60 of the mobile device.

Additional Exemplary Embodiments Of USB Adapters

Shown in fig. 4 is a schematic diagram of an additional exemplary embodiment of a USB adapter 300 that is coupled to a mobile device 10. The exemplary USB adapter 300 comprises a USB connector 302, a power converter 304, a plug unit 306, and an identification subsystem

308. The USB connector 302, plug unit 306, and identification subsystem 308, preferably correspond to the USB connector 102, plug unit 106, and identification subsystem 108 which were described earlier with respect to the first embodiment. Similar to the first embodiment, the additional embodiment may optionally be equipped with various plug adapters 314N, 314D, 314B, and 314 that preferably are releasably attachable to plug unit 306 so that the appropriate plug adapter 314N, 314D, 314B, or 314 can be selected by a user to allow the USB adapter 300 to couple to and receive energy from an available power socket 310N, 310D, 310B, or 310. The exemplary USB power converter 300 further comprises a charging subsystem 316 and battery receptacle 318 for coupling the USB adapter 300 to an external battery 320 that may be optionally coupled thereto.

The battery receptacle 318 provide a location for releasably coupling an external battery 320 thereto so that the external battery can be charged via the USB adapter 300. This provides the USB adapter 300 with a mechanism for charging, for example, a mobile device's primary or spare battery when the battery has been separated from or is not coupled to the mobile device 10.

To accommodate this functionality, the power converter 304 is capable of providing the proper voltage levels for the USB connector 302 and also capable of providing necessary voltage and current levels to drive a battery charging subsystem 316. The power converter 304 is preferably a dual power converter that may be constructed using conventional or non-conventional architectures. With respect to the portion of the power converter 304 that provides energy to the USB connector 302, that portion is preferably similar in construction and function to the power converter 104 of the first embodiment.

Preferably, the charging subsystem 316 performs in a substantially similar manner to charging subsystem 58 of the mobile device 10. But, for efficiency and simplicity of design,

certain aspects of the dual power converter 304 and the charging subsystem 316 may be combined, as both are local to the USB adapter 300.

Other alternative embodiments of the USB adapter may include various combinations of components described above with respect to the first and additional embodiments. Another embodiment of the USB adapter may include a second or more auxiliary USB connectors. A USB adapter having one or more auxiliary USB connectors may optionally be configured such that one or more of the auxiliary USB connectors may have power from the USB adapter's power converter made available to it so that multiple USB devices may draw power simultaneously. Preferably, a USB adapter having multiple auxiliary USB connectors will be configured such that the data lines in the auxiliary connectors can, on a selective basis, be electrically connected to or disconnected from the data lines in the primary USB connector. This allows a mobile device connected to the primary USB connector to receive energy from the adapter regardless of whether a USB host or hub is connected to an auxiliary USB connector. It is also contemplated that a USB adapter may be embodied in a USB host or hub.

Conclusion

The embodiments described herein are examples of structures, systems or methods having elements corresponding to the elements of the invention recited in the claims. This written description may enable those skilled in the art to make and use embodiments having alternative elements that likewise correspond to the elements of the invention recited in the claims. The intended scope of the invention thus includes other structures, systems or methods that do not differ from the literal language of the claims, and further includes other structures, systems or methods with insubstantial differences from the literal language of the claims. Although the embodiments have been described with reference to the USB interface, it is

contemplated that the invention could be applicable to devices and systems that use other standard interfaces such as the IEEE 1394 interface.